# Juvenile Chinook Salmon Distribution, Diet And Prey Resources Below The Locks

Charles Simenstad, Jason Toft, Melora Haas, Michele Koehler, Jeff Cordell
Wetland Ecosystem Team, School of Aquatic and Fishery Sciences, University of Washington
simenstd@u.washington.edu

Kurt Fresh
NOAA Northwest Fisheries Center

Paul Devries
R2 Resource Consultants

As a part of the US Army Corps of Engineers-Seattle District's Lake Washington General Investigation, in 2001 the University of Washington-School of Aquatic and Fishery Sciences' Wetland Ecosystem Team conducted studies of juvenile salmonids (*Oncorhynchus* spp.) and other fishes in the near vicinity of the Hiram M. Chittenden Locks, Shilshole Bay and the adjoining Puget Sound nearshore. The objectives of these investigations were to (1) recover in Shilshole Bay PIT-tagged juvenile chinook salmon (*O. tshawytscha*) that have used alternative pathways through the Locks, (2) assess the overall use of Shilshole Bay by juvenile salmon, irrespective of their origin, and related (potential predators and competitors) fishes, and (3) document juvenile salmon diet and prey resources in the greater Shilshole Bay estuary. Documentation of the PIT-tagged juvenile chinook were conducted in close coordination with the comprehensive studies of their migration from the Lake Washington/Ship Canal system through the Locks conducted by the USACE-Seattle District, R2 Resource Consultants and the Washington Department of Fish and Wildlife. Sampling involved both weekly, systematic beach seine sampling at 11 nearshore (intertidal/shallow subtidal) sites across the estuarine gradient between the Locks and West Point/Golden Gardens between May and October 2001, and intensive "blitz" sampling during 18-22 June 2001, to obtain maximum recovery of PIT tags. Basic data from these collections included: species, wild/adipose clipped, length, stomach contents (gastric lavage) and recovered PIT tag data. Diet composition was analyzed by the components of the Index of Relative Importance (IRI; frequency of occurrence, and numerical and gravimetric composition). To document prey resources, we also conducted biweekly sampling of (a) epibenthic prey resources at six site using excavated sampling cylinder and (b) pelagic prey at four sites (including one upstream of Locks) using vertical plankton hauls.

Overall, juvenile salmon constituted 11% of the total number of fishes captured in the nearshore within the study region, surpassed only by Pacific herring (*Clupea harengus pallasi*) and shiner perch (*Cymatogaster aggregata*), and equaling Pacific staghorn sculpin (*Leptocottus armatus*) and other sculpin (Cottidae). Shiner perch often dominated catches throughout the sampling period, while juvenile salmon were most prominent between late April and late June; pulses of juvenile salmon also appeared sporadically in catches through mid-August and persisted in low density completely through October. Chum salmon (*O. keta*) dominated the juvenile salmonid assemblage until after June, while chinook and coho were less abundant but persisted longer. Hatchery (adipose fin clipped) chinook dominated the chinook catches until late June; henceforth unmarked and marked chinook catches were relatively comparable. Catches of juvenile salmon

were generally highest in close proximity to the Locks, particularly at the "Railroad" site, and decreased with increasing distance along the estuarine gradient from the inner Shilshole Bay; however, catches at Golden Gardens, the most distant, northerly site, were often high. As indicated by the occurrence of juvenile chum salmon, the origin of juvenile salmon within Shilshole Bay, even adjacent to the Locks, was not restricted to immigrants from the Lake Washington system. The occurrence of PIT-tagged juvenile chinook from the Lake Washington system during intensive sampling in inner Shilshole Bay, adjacent to the Locks, indicated a rapidly declining residence between June 18-20, suggesting only ~1-3 day residence time. PIT tag recovery for juvenile chinook was 4.4% of the total catch, and 2.3% for juvenile coho salmon (*O. kisutch*) during this period.

Diet composition of juvenile salmon indicated a strong influence of discharge from the Lake Washington system in the form of freshwater zooplankton (i.e., *Daphnia* spp.), and to a lesser degree pelagic marine/estuarine zooplankton. Insects and epibenthic crustaceans and polychaete annelids were more prominent in the diets of juvenile salmon in the outer Shilshole Bay and adjoining nearshore sites, and slightly more in unmarked than marked chinook salmon. Potential epibenthic prey (harpacticoid copepods, gammarid amphipods) are considerably more abundant at the outer Shilshole Bay sites than at the inner Bay sites. In contrast, neustonic prey were ~an order of magnitude more abundant in the inner Bay than in the outer Bay, dominated in both cases by *Daphnia* sp., *Bosmina* sp. and *Diacyclops thomasi* discharging from the Locks. The effect of the outflux of freshwater zooplankton from the Lake Washington/Ship Canal system is also demonstrated by the vertical zooplankton sampling, where densities above the locks averaged ~72,700$m^{-3}$ (~73% *Daphnia* sp., *Bosmina* sp., and *D. thomasi*), compared to ~43,500$m^{-3}$ in inner Shilshole Bay (~53% the freshwater taxa), and ~25,000$m^{-3}$ in the outer Bay (almost entirely estuarine/marine taxa).

Shilshole Bay appears to be a transitory habitat for juvenile salmonids of both Lake Washington and Puget Sound origins. Foraging of most salmon is focused on either pelagic zooplankton, most of which originates from allochthonous freshwater production in the Lake Washington/Ship Canal system, and to a lesser degree drift/neustonic insects; autochthonous littoral production of epibenthic prey, and potentially input of riparian insects, do not appear to play a large role in supporting juvenile salmonids in the inner Bay, although these sources may be more important in the outer Bay and adjoining nearshore. In some aspects, the Shilshole Bay ecosystem represents an aberrant estuary in terms of the concentrated foraging and prey availability based upon lentic freshwater production. The unique(?) role of Lake Washington/Ship Canal zooplankton production in supporting juvenile salmon feeding, and potentially attracting juvenile salmonids and other fishes from Puget Sound, should be considered in future Locks and fisheries management decisions.